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Production of Edible Film from Isolate Soy Protein with Addition of Palmitic/Lauric Acids

Firnanda Rayyan Muhammad[1)] and Vita Paramita[*1)]

Industrial Chemical Engineering, Faculty of Vocational School, Diponegoro University
Jl. Prof. Soedarto, SH, Tembalang, Semarang

[*)] Corresponding author: vparamita@live.undip.ac.id

Abstract *– On the structure, physical and functional properties of soy protein isolate/sodium alginate films, the influence of chain length and concentration of various fatty acids (palmitic acid and lauric acid) was evaluated. The fatty acid content of the films was validated by Fourier transform infrared spectroscopy. SPI (5.0 g) and glycerol (2.5 g) were dissolved in 150 mL distilled water with mechanical stirring to make a pure SPI film. with mechanical stirring for 40 min. For the modified films, SPI, sodium alginate, and glycerol were dissolved in distilled water with mechanical stirring for 30 min. Lauric acid (LA) or palmitic acid (PA) was added to the solution of the film-forming solution was poured into a Petri dish, and the film was dried. The opacity of films treated with fatty acids increases with increasing fatty acid chain length or concentration. The ability of a film to act as a moisture barrier is strongly influenced by the type and concentration of fatty acids. From this research it was found that the most optimal conditions for making edible film made from protein isolate with the addition of lauric acid and palmitic acid are a fatty acid ratio of 2:3, drying at a temperature of 75℃ and drying for 3 hours to obtain a tensile strength value of 0.97 MPa and elongation of 24%.*

Keywords: *edible film, fatty acids, palmitic, lauric, isolate soy protein*
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INTRODUCTION

One of the soy products with strong functional qualities is soy protein isolate (SPI), which is often used in the food industry to make various dishes and drinks (Hasriandy Asyhari et al., 2018). About 90% soy protein isolate (SPI), which is made from soy flour, contains 0.5% Fat, 4.5% Ash, 0.3% Carbohydrates, and 90% Protein. ISP has better film forming capacity. For SPIs with filmmaking capabilities, much work has been done so far to create non-biodegradable materials (Chen et al., 2022). Apart from polysaccharides and lipids, soy protein isolate (SPI) is an important component for film formation, but currently does not have antibacterial properties. Based on SPI, the inclusion of antibacterial agents can improve the functional characteristics of edibles (Eka Putri., et al., 2018).

Organic acids called fatty acids are straight chains with a hydroxyl group (-COOH) at one end and a methyl group at the other end ($-CH_3$). Typically, natural fatty acid chains have an even number of carbon atoms, ranging from four to twenty-two. Myristic (14:0), palmitic (16:0), and stearic (18:0) are the most common saturated fatty acids, and they were found in fish species (Karnila et al., 2006). Natural waxes, fatty acids, and emulsifiers are lipids (fats) that are often used in the production of edible films (Yusuf et al., 2014). The use of lipids in edible preservative films has

attracted recent interest in the food industry. Because they contain many long-chain fatty alcohols and alkanes, lipids have high hydrophobicity which helps retain moisture and reduces packaging complexity (Sogut et al., 2019).

To achieve better moisture barrier qualities, many composite films can be combined with hydrophobic lipid molecules and hydrophilic structural matrices. Therefore, one typical method to improve the moisture barrier capability of edible films is to combine biopolymer-based film-forming solutions with hydrophobic chemicals (Hashemi Gahruie et al., 2020).Food fit for consumption may have an edible film layer on it. This film is naturally biodegradable. Edible films can be mixed with certain elements to increase the functional value of the packaging itself in addition to being biodegradable. One option that is often used as an environmentally friendly packaging material to reduce environmental impacts is edible film. A thin layer called edible film functions as a coating or food packaging material that can be consumed together with the packaged goods (Chen et al., 2022). The characteristics of edible film are almost the same as synthetic packaging made from plastic. These films must be able to retain water to prevent product moisture, have selective permeability to certain gases, control the transfer of dissolved solids to retain color, natural pigments, and nutrients, and be a carrier for additives such as colorants, preservatives, and added aromas to improve material quality. food. (Hashemi Gahruie et al., 2020).

Soy flour products with a protein content of at least 90% of dry matter and contain no fat or low fat are called soy protein isolate. SNI 3818:2014, namely maximum water content of 70%, maximum ash content of 3%, minimum protein content of 11%, and maximum fat content of 10%. According to one study, raw red bean protein is only 56% digestible, compared to 91% for soy protein isolate (Utami & Anjani, 2016). Lean soy flour, which contains about 90% protein, is used to make soy protein isolate (SPI), which has increased film-forming capacity. Much work has been done to create SPIs that can form films to replace non-degradable materials. After ultrafiltration, various molecular weights of soy protein have varying effects on the water vapor permeability and mechanical characteristics of edible films (Amado et al., 2020). Furthermore, (STUCHELL & KROCHTA, 1994) reported that SPI films were smoother and more transparent after heat treatment than after being left unheated, and enzymatic treatment increased.

RESEARCH METHOD

Materials and Tools

The materials used was ISP (Isolate Soy Protein) concentrate 90% protein, Sodium Alginate with 99% purity 80 mesh food grade, Glycerol, Lauric Acid, Palmitic Acid, and Aquadest. Using tools Hot plate Strirrer, Oven, Petri Dish, Digital, Beaker Glass, and Water Bath. The Research was done at Diponegoro University Industrial Chemical Engineering Laboratory.

Preparation Materials

SPI (5.0 g) and glycerol (2.5 g) were dissolved in 150 mL distilled water with mechanical stirring for 30 min to make a pure SPI film. Then, the film-forming solution was placed in a constant temperature water bath at 70◦C with mechanical stirring for 40 min. For the modified films, SPI (5.0 g), 0.5 g sodium alginate (NaAlg), and 2.5 g glycerol were dissolved in 150 mL distilled water with mechanical stirring for 30 min. Next, lauric acid (LA) or palmitic acid (PA) was added to the solution and placed in a constant temperature water bath at 70 ºC with mechanical stirring for 40 min each. 20 mL of the film-forming solution was poured into a Petri dish, and the film was dried for about 3 h at 65 ºC. Finally, the dry film is peeled from the cup.

X-Ray Diffraction (XRD)

X-Ray Diffraction (XRD) is used to determine the crystal structure in a solid sample. The results of XRD testing are in the form of a diffraction pattern or commonly called a diffractogram which can be used to determine the crystalline phase contained in a mixture, the number of crystalline phases present in the mixture, and the amorphous material contained in the mixture. The X-ray producing target metal used is Cu metal and has a minimum test capability at an angle of 2 θ (Munasir et al., 2012).

Tensile Strengh

Tensile test is a test used to determine the mechanical properties of a sample in research. Tensile testing is a method used to test the strength of a material by applying a force load in the opposite direction. Tensile testing, also often referred to as tension testing, is one of the most basic/fundamental mechanical tests, very simple, inexpensive and has been standardized throughout the world such as in America ASTM E 8 and ASTM E 8M and in Japan JIS 2241(Fadilah, 2020).

Melting Point

The melting point test is determining or knowing the melting point of a substance. The melting point test is one of the most important and basic parameters for finding out about the properties of a substance, determining its purity, and knowing the character of the organic and inorganic compounds contained in the substance (Chen et al., 2022).

RESULTS AND DISCUSSION

It is known that the TSR 6 sample obtained a tensile strength of 0.97 MPa which is the largest tensile strength value, and the TSR 3 sample obtained was 0.21 MPa which is the smallest tensile strength value. This is influenced by the variables T and S, namely T is the drying time and S is the drying temperature. TSR 6 uses a temperature of 75°C and a drying time of 3 hours, while TSR 3 uses a temperature of 65°C and a drying time of 4 hours.

Table 1. Data on Edible Film Isolate Protein Results

No	Changed Variable			Interaction				XRD	Tensile Strengh	Melting Point
	T	S	R	TS	TR	SR	TSR			
1	-	-	-	--	--	--	--- (TSR1)	X1	E1	
2	+	-	-	+-	+-	--	+-- (TSR2)		E2	
3	-	+	-	-+	--	+-	-+- (TSR3)		E3	
4	+	+	-	++	+-	+-	++- (TSR4)		E4	P4
5	-	-	+	--	-+	-+	--+ (TSR5)		E5	
6	+	-	+	+-	++	-+	+-+ (TSR6)		E6	
7	-	+	+	-+	-+	++	-++ (TSR7)		E7	
8	+	+	+	++	++	++	+++ (TSR8)		E8	

Tensile Strengh

Table 2. Result of Tensile Strengh

Sampel	Tensile Strength (MPa)	Elongation at break (%)
TSR 1	0.43	12.2
TSR 2	0.42	6.2
TSR 3	0.21	4.8
TSR 4	0.94	3.0
TSR 5	0.91	26.6
TSR 6	0.97	24.4
TSR 7	0.26	7.2
TSR 8	0.49	14.4

From the data obtained, it is known that the relationship between temperature and time is interrelated. In research by Chen et al. (2022) obtained a result of 0.14 MPa with a drying temperature of 65°C and a drying time of 3 hours. At higher drying temperatures, higher tensile strength results are obtained, this is due to the stronger peptide bonds that make up proteins as the water content decreases at higher temperatures. (Amado et al., 2019).

Melting Point DSC

In the results of the DSC analysis, it is known that there were 2 thermal events that occurred, namely event 1 which started at a temperature of 60.62-67.19°C which was exothermic with heat produced of -1.79J/g.

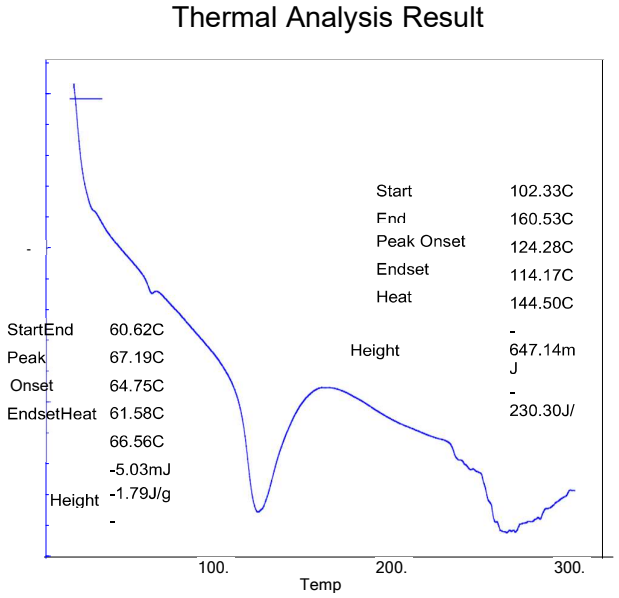

Figure 1. Result of Melting Point

Where in this incident decomposition of lauric acid and palmitic acid occurred which caused the edible film which started in a glass state to become a rubber state. In event 2, starting at a temperature of 102.33-160.53°C, water evaporation occurred in the protein isolate and a protein denaturation process occurred (Chen et al., 2022).

X-Ray Diffraction (XRD)

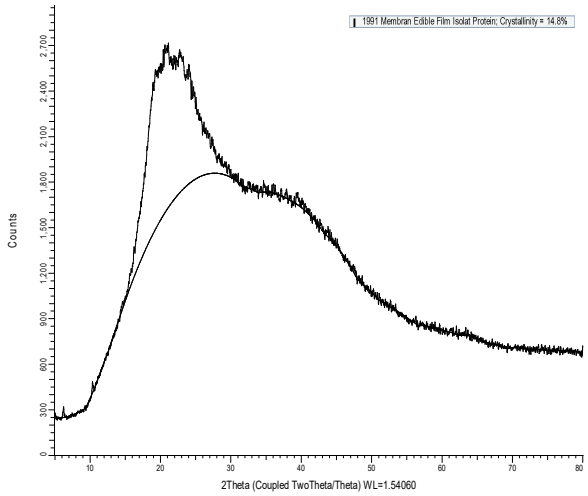

Figure 2. Result Of XRD

In the results above, the crystallinity percentage was 14.8% and the amorph percentage was 85.2%, which states that the edible film in this study has a predominantly amorphous particle structure. In the XRD spectrum in Figure 2, it is known that the amorph peak is at 2 θ = 15-65 θ and the crystal peak is not observed separately from the amorph peak. So it can be concluded that the crystal peak is contained within the amorph peak, which indicates that the crystal particles are distributed within the amorph particles. The 14.8% crystallinity value obtained in this research came from the process of adding lauric acid and palmitic acid which tend to form crystalline particles (Chen et al., 2022), so that in this research the crystallinity value can still be obtained even though it is not dominant.

CONCLUSION

From this research it was found that the most optimal conditions for making edible film made from protein isolate with the addition of lauric acid and palmitic acid are a fatty acid ratio of 2:3, drying at a temperature of 75°C and drying for 3 hours to obtain a tensile strength value of 0.97 MPa and elongation of 24%. The characterization results from DSC are recommended for use on products with temperatures below 60.62°C to avoid thermal degradation. According to the XRD results obtained, the edible film in this study has an amorphous structure which causes the tensile strength value to be relatively smaller.

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